

# INSTITUTE AND FACULTY OF ACTUARIES

## EXAMINERS' REPORT

April 2022

### CP2 - Modelling Practice Core Practices Paper Two

#### Introduction

The Examiners' Report is written by the Chief Examiner with the aim of helping candidates, both those who are sitting the examination for the first time and using past papers as a revision aid and also those who have previously failed the subject.

The Examiners are charged by Council with examining the published syllabus. The Examiners have access to the Core Reading, which is designed to interpret the syllabus, and will generally base questions around it but are not required to examine the content of Core Reading specifically or exclusively.

For numerical questions the Examiners' preferred approach to the solution is reproduced in this report; other valid approaches are given appropriate credit. For essay-style questions, particularly the open-ended questions in the Specialist Advanced (SA) and Specialist Principles (SP) subjects, the report may contain more points than the Examiners will expect from a solution that scores full marks.

The report is written based on the legislative and regulatory context pertaining to the date that the examination was set. Candidates should take into account the possibility that circumstances may have changed if using these reports for revision.

Sarah Hutchinson  
Chair of the Board of Examiners  
July 2022

## **A. General comments on the *aims of this subject and how it is marked***

The aim of this subject is to ensure that the successful candidate can analyse data, develop a model, and document the work (including maintaining an audit trail for a fellow candidate and senior actuary). They should be able to analyse the methods used and outputs generated and communicate to a senior actuary the approach, results and conclusions.

The subject is split into two papers. The second, dealt with in this report, covers the objectives:

- Ability to analyse the methods used and the model's outputs.
- Ability to apply and interpret the results.
- Communication of the approach, results and conclusions to a senior actuary.

As the focus of the subject is on communication, the majority of the marks available are for the documentation and outputs generated rather than for technical modelling skills. For example, a technical mistake is only penalised once and candidates can still earn marks for accurate and clear communication of what was done.

Candidates who give well-reasoned points not in the marking schedule are awarded marks for doing so.

It is strongly recommended that prospective candidates attempt a number of past papers and look closely at both the model solutions and the marking schedule to get a better idea of the range of conclusions and next steps which could be submitted.

## **B. Comments on *candidate performance in this examination.***

### **Modelling**

Candidates performed well in the modelling of this paper. by building out the model for the new consideration. The main source of error was in calculating the expected value of the GDP index. Most candidates calculated the average value of the simulations rather than project out the index with an assumption of 3% annual growth (i.e. the first GDP parameter).

The charts section was well answered. The exception being the first chart, where many candidates chose a bar chart, whereas a line chart would have clearly demonstrated the patterns in the data.

### **Summary**

The methodology was well set out by better candidates, with generally clear explanations covering most of the main steps. There is a tendency to use less detail than is expected by the CP2 examiners, but this is still an area that is well answered.

The number of candidates that either copy the provided audit trail into the summary paper or write the summary in the style of an audit trail (with numerous references to the spreadsheet) continued to be a rare occurrence, taking heed of previous advice. The summary paper should be a standalone document that doesn't make any reference to the

spreadsheet. Inserting 'reasonableness checks' (which belong in the audit trail) should be replaced by explaining and commenting on results.

Most candidates managed to make several obvious statements about the results observed in the graphs. However, these were often rather brief and basic, focussing on the 'what' but not the 'why'. This area remains the clearest distinction between candidates, as it shows an understanding of the assignment and an ability to communicate this. Candidates should aim to explain what they see and find a reason for it. As an example, many candidates noted that there is an increase in profits as a result of adding the side orders, with the luxury strategy benefiting the most. Only the better candidates went on to explain reasons for this (many fixed costs remain unchanged and under the luxury strategy the proportion of purchases adding a side order being higher).

Most candidates produced plenty of next steps, but only the better candidates linked these clearly to the scenario in the question and explained how each step would help. Those who produced a 'scattergun' list of short one-liners earned lower marks. In particular, the use of a template list of next steps can often be noticed, either by not making these relevant to the assignment, or including steps which are patently out of place. Submissions of steps that are irrelevant or inappropriate for the assignment will therefore tend to be awarded low marks.

Often, suggested next steps will be areas that are already covered by the assignment, such as sensitivity testing a parameter which was changed in one of the scenarios. Candidates should ensure that their suggestions are relevant to the situation and make sense as an additional area of investigation. They should also try think a bit deeper and explain the benefit achieved from doing this - which will ensure that they get maximum credit for each idea.

### **C. Pass Mark**

The Pass Mark for this exam was 58  
1097 presented themselves and 644 passed.

## Solutions for Subject CP2-2 - April 2022

### Q1

(i)

Calculation of requested statistics:

Expected value of projected GDP index [1]

Min and max for each year [½]

Quartiles for each year [½]

(ii)

Calculation of additional side order modelling

Calculation of side order demand (budget strategy) [1½]

Calculation of side order demand (luxury strategy) [1½]

Calculation of annual profits with side orders (costs, revenues and subsequently profits) [2]

Calculation of total ten-year profits with side orders [1]

Calculation of revised statistics (minimum, maximum, mean, median) with side orders [1]

**[Total 9]**

*The majority of candidates managed to complete the modelling required, calculating statistics to support the plotting of charts and expanding the existing model to incorporate the proposed addition of side orders*

### Q2

Chart Production

(i)

Construction of chart showing projected distribution of the GDP index over the next ten years (minimum, maximum, quartiles) and projection of expected GDP index. [2]

(ii)

Construction of chart showing the minimum, maximum, mean and standard deviation of total ten-year profit simulations on budget and luxury scenarios with no side orders. [2]

(iii)

Construction of chart showing the minimum, maximum, mean and standard deviation of total ten-year profit simulations on budget and luxury scenarios with side orders. [2]

**[Total 6]**

*Charts were generally well constructed, and most candidates scored well in this section*

### Q3

Analysis

(i)

Table or chart showing the budget and luxury ten-year progression of annual profit on the minimum, median and maximum simulations with no side orders [2]

(ii)

Table or chart showing the budget and luxury ten-year progression of annual profit on the minimum, median and maximum simulations with side orders

[2]

**[Total 4]**

*Many candidates made no attempt to analyse the results. There is no right or wrong way to set out the results, merely that they are analysed and presented in such a way that the candidate can make observations, find patterns and provide explanations of these.*

#### Q4

##### Summary

(i)

Methodology (including purpose, data, approach and assumptions)

Statement of purpose. [1]

Data used and source [1]

Data validation/review [1]

Assumptions: up to 5 marks for a good list of “added value” assumptions. [5]

Award a total of 1 mark for restating assumptions from the audit trail. Award 1 mark for any valid assumption not included in the audit trail.

##### Description of steps

###### GDP projection

Calculation of  $z(t)$  projection [1]

Calculation of log GDP index projection [ $\frac{1}{2}$ ]

Conversion to GDP index projection [ $\frac{1}{2}$ ]

Calculation of GDP index less 100 [ $\frac{1}{2}$ ]

###### Profit projections

Calculations of number of pizzas sold for all years and simulations in budget strategy [1]

Calculations of components of annual profits; sales, costs, revenue and annual profits [3]

Calculation of ten year profit [ $\frac{1}{2}$ ]

Explaining differences for luxury profit strategy [1]

###### Side order modelling

Calculation of percentage of pizzas sold with one side for all years and simulations in the projection for both strategies. [2]

Calculation of extra profit from side orders; extra costs, extra revenue, revised annual profit, revised total ten year profit for both strategies. [2]

###### Calculation of statistics

Calculation of minimum, maximum, mean and standard deviation statistics for both scenarios (i.e. no sides and sides) and both strategies [1]

Senior actuary can understand what has been done

The level of detail included is appropriate for a senior actuary. [2]

All methodology steps are set out clearly. [2]  
 The senior actuary would be able to understand the approach taken without having to refer to other documentation. [1]

(ii)

Results, including charts

Chart of the comparison of projected distribution of the GDP index over the next ten years. [1]

Table of summary statistics. [1]

Chart showing summary statistics with no side orders [½]

Chart showing summary statistics with side orders [½]

Chart or table showing ten year profit projection with no side orders [1]

Chart or table showing ten year profit projection with side orders [1]

(iii)

Conclusions

Where results are observed but not explained only ½ mark should be awarded, unless the mark is specifically stated to be for an observation.

Analysis of GDP simulation

Observation that the median GDP index is smoothly increasing [1]

Because it is expected be similar to the expected projection of the GDP index with random variation [1]

And the expected projection will increase by 3% per annum [1]

The median GDP (141.0) after 10 years is close to the expected value of  $100 \times 1.03^{10} = 134.4$  [1]

This seems reasonable and would be expected to be closer to 134.4 if a larger number of simulations were carried out. [1]

Discussion of the other quartiles of the GDP projection. 25th centile remains mainly above the 2022 level of the index. This shows that the majority of GDP progressions do not project a sustained fall below the 2022 index level. 50% of projections result in an index level of between 111 and 163 by 2032. Other valid observations should be awarded marks. [1]

The minimum and maximum lines show the upper and lower bounds of projected GDP. This indicates that the distribution has relatively long tails with most projections concentrated around the expected values. [1]

The general pattern seems reasonable for the projection of GDP in a country as it can be influenced by a number of unknown influences both positively and negatively (for example war, terrorism, trade agreements, politics, climate change, health challenges and natural disasters) but is usually expected to follow a general small upward trend. [1]

Analysis of ten-year profit statistics without side orders

Average profits on 'budget' and 'luxury' strategies are similar with the luxury strategy average profit being slightly higher. [1]

It can be seen that on the budget strategy all outcomes, including the minimum, are positive and they are distributed closely around the mean with a range of \$521,963 to \$757,123. The standard deviation of \$45,838 is relatively low. [1]

This shows that the number of budget pizzas sold is not very sensitive to the level of GDP. [1]

The chart shows that the luxury strategy has a much larger range of profits, with the minimum being a small loss of \$46,530 and the maximum being approximately twice as high as the budget scenario maximum profit at \$1,572,084. [1]

The standard deviation of the luxury strategy is over six times higher than the budget strategy standard deviation. [1]

This shows that the 'budget' strategy is less sensitive to the GDP index than the 'luxury' strategy [1]

Explanation for why luxury strategy is more sensitive to GDP. i.e. some people can only afford luxury pizzas in strong economy when they have higher disposable income, some potential luxury customers may switch to budget when economy is doing poorly. Or other reasonable suggestion. [2]

Analysis of ten-year profit statistics with side orders

Average profits increase for both strategies when side orders are added [1]

This could be explained by the fact that the fixed overheads, advertising and delivery costs and one-off luxury strategy development costs are not increased by the addition of side orders. As the side orders' selling price is greater than the side order variable costs, if the expected side order sales cover the relatively small one-off side order development costs, they will increase the overall profit. [2]

The luxury strategy mean ten year profit increases more due to the addition of side orders than the budget strategy [1]

This could be explained because side orders are profitable and Mr Rolfe expects a higher percentage of luxury pizzas to be sold with a side as reflected by the 85% base percentage in the luxury side order formula, compared to 50% on the budget strategy. [1]

The higher percentage of side orders expected to be sold with luxury pizzas might be because once a customer can afford a luxury pizza they can also more likely to afford a side order. [1]

The standard deviation of both strategies increases by a similar percentage when side orders are added. [1]

This is because side orders add an additional variability with respect to GDP index [1]

The increase to the budget strategy standard deviation is slightly larger as the factor parameter in the formula for sensitivity for one unit of GDP index change is higher at 0.13 for the budget strategy. [1]

The minimum ten-year profit has increased on both strategies, with the luxury strategy minimum ten year profit being greater than 0. Although it is still lower than the minimum on the budget scenario, it may make the luxury scenario with sides more appealing by removing the expected possibility of a loss [1]

The maximum ten-year profit has increased on both strategies due to the potential for additional profits on side orders. [2]

Progression of profit without side orders

The luxury strategy's profit is reduced at time 1 (2023) by the initial one-off development costs. [1]

The ten-year profit projection shows the greater variability of the luxury strategy with respect to the GDP index [1]

And the greater likelihood of the luxury strategy to generate negative profits over ten years. [1]

This is because the overall sale of luxury pizzas is more sensitive to the level of the GDP index than the budget pizzas. [1]

This is because of the parameters of the model which have a greater sensitivity to change in GDP [1]

Progression of profit with side orders

Adding side orders to both models increases the range of profits on both strategies. [1]

The median luxury strategy profit projection is consistently higher than the median budget strategy projection. [1]

This is because a higher percentage of luxury strategy pizzas are expected to be sold with a profitable side order and this percentage varies less with GDP index fluctuations on the luxury strategy. [1]

The minimum profit on the luxury with sides strategy is consistently below that of the budget with sides strategy. [1]

This is because the overall sale of luxury pizzas is still more sensitive to the level of the GDP index than the budget pizzas. [1]

In particular the minimum profit on the luxury with sides strategy is consistently below that of the budget with sides strategy and falls close to zero profits on the worst projected GDP index outcomes. [1]

Conclusions

Recommendation of preferred strategy - budget vs luxury, with vs without sides [2]

With discussion on attitude to risk [1]

And affordability of development costs [1]

Conclusion that the actual outcome will depend on experience, particularly of the GDP index and whether the parameters and models used are borne out in practice. [1]

Any other valid conclusion [1]

[Marks available 45, Maximum 22]

(iv)

Next steps

Validate the parameters Mr Rolfe provided [1]

Against, for example, other luxury pizza providers and Fresh Pizza's previous business accounts and records). [1]

Validate that the linear model of pizza sales w.r.t GDP index is appropriate [1]

Consider modelling other factors affecting the number of pizzas sold, for example the number of competitors in the local market to determine the potential impact on profits [2]

Back test the time series model for GDP to check that the model fits the recent past GDP index, unless adjustments have been intentionally made to reflect forecast changes. [1]

Consider the effect on profit projections of modelling the possibility of more than one side order per pizza order at different prices, or offering drinks for sale [2]

Consider the impact of offering discounts on more than one pizza per order (as long as the price offered is greater than the variable costs per pizza). [2]

Sensitivity test the profit outcomes for different overheads or delivery costs [1]

Expand the model to allow for the option of selling both budget and luxury pizzas at the same time [2]

Consider the potential for a change in the demand for pizzas, for example due a national chain entering the local market or campaigns for healthy eating. Carry out stress testing to establish the minimum level of pizzas sold for each scenario to break even on average and consider the likelihood of these levels of demand. [2]

Consider potential for changes to food business regulations and the associated costs, for example increased hygiene regulations or minimum wages for delivery drivers and include these in the profit simulations.	[1]
Consider extending the model for a longer time period	[1]
Consider modelling on a monthly or quarterly basis to allow for seasonal changes in demand for pizzas and identify any potential periods of negative cashflow.	[1]
Confirm that the funds to develop a luxury pizza brand or offer side orders are available or if alternative funding would be required.	[1]
Discount profit projections to arrive at a net present value of ten-year profit to understand if the time value of money of different patterns of profits makes a difference.	[1]
Allow for inflation within the model on both the costs of materials and the price of pizzas (potentially at different rates) to assess the potential impact on the profit.	[2]
Allow for tax on scenarios with positive profit	[1]
Calculate the IRR of the investment into developing the luxury strategy and/or side order offering to check if the investment is worthwhile	[1]
Investigate the possibility of whether the country is likely to introduce higher taxes on non-healthy food products	[1]
Test the model against emerging experience, for example actual levels of GDP index against actual pizza sales and side orders on the chosen strategy to check the validity of the models and adjust them if necessary	[1]
Obtain a peer review of the work done to date	[1]
Any other valid next steps	

[Marks available 27, maximum 18]

(v)

Drafting

Clear / concise drafting of the objective, and data summary/description	[1]
Clear / concise drafting of the assumptions and methodology	[2]
Clear / concise drafting of the results and conclusions	[2]
The summary report is written in clear, crisp and flowing English.	[2]
Accurate spelling	[1]
The summary is well laid out, in a reasonable order, with good formatting to aid clarity	[2]

[Total 81]

*The description of methodology was usually awarded reasonably well. Better candidates are able to describe what was done, and how it was done. Most candidates also managed to include the majority of the requested results in the summary.*

*However, candidates struggle to comment on the results, and draw useful conclusions. Only the better candidates score well on this section, with most earning well under half of the marks on offer.*

*Next steps are usually better, with most candidates coming up with a number of reasonable suggestions. There was an increased number of candidates providing a long list of poorly tailored ideas. It is important that candidates elaborate on these next steps, providing justification for why they make sense for the given assignment.*

[Paper Total 100]

## **END OF EXAMINERS' REPORT**